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ABSTRACT

This publication contains a glossary of acronyms; an editorial (Ingram); "Integrative Assignments and Design" (Biles, Palmer); "Computer-Based Education: A Student's Response" (Landau); "Taking the RISC Reduced Instruction Set Computer in FHE Further and Higher Education" (Meeke); "Engineering Education in Denmark" (Ingram); "STARNET: The Shape of Education in the Future" (Evans); and "Teaching the Social Implications of Technological Change" (Hall). (CML)

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The Further Education Unit (FEU) was established by the Department of Education and Science to give guidance and support to the further education system. FEU advocates and seeks to make possible a more co-ordinated approach to curriculum development, in support of its remit to promote, encourage and develop better learning opportunities in further education. For more information, please contact:

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Acronyms and Abbreviations

BTEC	Business and Technician Education Council
C&G	City and Guilds of London Institute
CAD	Computer-Aided Design
CAL	Computer-Assisted Learning
CAM	Computer-Aided Management
DTI	Department of Trade and Industry
FEA	Finite Element Analysis
FEU	Further Education Unit
FHE	Further and Higher Education
LEA	Local Education Authority
PIA	Programme of Integrated Assignments
RISC	Reduced Instruction Set Computer
ROM	Read Only Memory
TAFE	Technical and Further Education (Australia)

In the first issue of this Digest we published an article by Tom Stonier of Bradford University. We thought it might be interesting to get a student's view, so we asked Laura Landau to tell us what she thinks of the Bradford University scheme. Her attitude seems to be one of healthy scepticism.

Most colleges will now be concerned with PIAs - this acronym does not stand for 'Pursuit of Impossible Aims' but for BTEC's 'Programmes of Integrative Assignments'. We have an article, written by Les Biles and P M Palmer of Barrow-in-Furness Technical College, which deals with the problems involved in the effective management and design of integrative assignments and suggests some useful approaches to their solution.

Every month some new aspect of IT arises about which no self-respecting lecturer dare admit ignorance for fear of attracting a barrage of contumely from more supposedly informed colleagues. One such topic is that of RISC technology. Fortunately, we have been able to persuade Noel Meeke, the Director of Marketing and Enterprise at Cheltenham and Gloucester College of Higher Education, to explain what RISCs are and to speculate on their implications in FHE curricula.

It has been suggested that the Digest should, from time to time, include a short article on teaching and curricular matters in a European country. This seems an excellent idea. Our first article is about Denmark; the next will concern France. If there is anyone out there who has some experience of courses in Portugal or Greece, we would be pleased to hear from you.

To keep you up to date with developments we have included a brief item of news about STARNET, an interactive, satellite-based, audioconferencing system being piloted by Polytechnic South West.

Our final article in this edition raises the issue of teaching the social implications of technological change. We are indebted to Bill Hall of TAFE, FEU's comparable body in Australia, for permission to adapt a summary document prepared for his own constituency. We are not suggesting that the UK situation is identical to Australia's, but we need to consider the issues Bill raises with an open mind and take account of those that are relevant.

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Integrative Assignments and Design
L W Miles and P M Palmer,
Barrow-in-Furness Technical College

In some further education colleges subjects are taught in isolation, with little contact between the various lecturers. Sometimes similar topics arise, dealt with in more than one unit - for instance, the principles of tensile testing is taught in both Science and Materials Technology units. The establishment of course teams has given an opportunity for lecturers to be made aware of such overlaps so they can plan for course time to be more gainfully used.

The integration of theory with practical and project work causes problems and it is possible for students to have difficulty in applying their knowledge to problems that arise at work.

To assist integration of the curriculum elements, it is necessary to identify some common ground. An appropriate subject base would be Design. By careful choice of the product to be designed, any branch of engineering (or any combination of branches) can be involved. For instance, an assignment requiring the design of an electrical switch will involve elements of mechanical, production and electrical engineering.

PROGRAMME OF INTEGRATED ASSIGNMENTS (PIA)

BTEC's introduction of a PIA into First and National Certificates and Diplomas is an attempt to break down the barriers between subjects and should be welcomed as a

means of integrating them. There is now a requirement for assignments within FE courses to be modelled on the real-life problems students will encounter during their engineering careers. Employers are keen that students are given realistic problems which stimulate their interest in the learning process.

To devise a PIA, assignments must be appropriate to the experience and academic level of the student. There should be a theme which will identify and co-ordinate the subjects involved. A team approach is essential so individual lecturers can provide their particular expertise. BTEC's requirement for a core theme for integrative assignments can be met within a theme such as 'Design of a Product' as this permits the integration of material from a variety of subject units. A PIA implies that a number of assignments should be given, each connected by the core theme. To this end, each assignment needs a scenario which will place the student in the design role and should lead to issues requiring input from various subjects.

DESIGN OF A PRODUCT

The use of 'Design of a Product' as a core theme will require consideration of:

- research and development;
- market research;
- safety standards;
- effect on the environment;
- selection of materials;

means and processes of manufacture;
application of scientific principles;
communication - verbal, by computer,
drawing and report;
servicing and maintenance;
new technologies, such as computers
in industry.

SCENARIO

An example of a typical scenario for the design of a motor car foot pump is shown below (taken from PIA Level NII Workbook, Barton Education Services, 17 Holbeck Park Avenue, Barrow-in-Furness, Cumbria LA13 0LQ.):

In this assignment, you will be a member of a team of students selected by your lecturer. Your roles will be market researcher, design engineer, detail draughtsperson and test engineer. Your company is Light Engineering plc which manufactures ancillary goods for the automotive industry. The company has decided to investigate the possibility of manufacturing foot pumps for car tyres. They are concerned about the demand for such a product, since many drivers inflate their tyres when they buy petrol at a service station. Therefore, a market research exercise must be carried out to establish the demand. Meanwhile, it is decided to start the design process by buying competitors' foot pumps to see what the opposition has to offer.

After the scenario, a series of structured questions set by the team of lecturers is given.

THE ASSIGNMENT

Each assignment should be arranged around a simple product or component and the form of questions should be straightforward. Assignments with a design core theme may be for individuals or groups of students. In group assignments, students produce the bulk of work in their own area, but in consultation with others in the group.

This entails the selection of a group leader to co-ordinate their efforts.

The assignments used in a PIA can each have a slightly different emphasis, depending on the timetable for each subject. **The course team should organise a scheme of work or year plan for the complete year's work, indicating how the elements from each course unit are included.** This will determine the timetable of the various topic areas from different subjects and can only be done by consultation with the team of lecturers concerned. A temporary year plan should be devised initially, based on the sequence of objectives given by BTEC for each unit and the assignments arranged to suit the year plan. The first assignment will be the most difficult to organise since the topic areas covered at the beginning of the year are limited. After this initial matching of topic areas and assignments, it may be necessary to reorganise the elements to suit the assignments and thus modify the year plan. As the planning of the year's work progresses, assignment design becomes easier as they incorporate issues identified during previous work.

TIME INVOLVEMENT

The PIA will involve lecturers and students in a considerable amount of work. However, this work has a non-traditional format and reduced time may be allocated to individual subjects. Consideration should be given to topic areas which can be delivered and assessed in the PIA, thus reducing the assessment and teaching time for each unit. An assessment schedule must be devised for the PIA and structured so that the lecturers concerned are given guidance on input and the objectives they have to assess. This will require co-operation between lecturers. With a number of assignments with slightly different emphases, the load between staff should be approximately even.

IMPLEMENTING THE PIA

During the PIA teaching period, lecturers act as advisers, giving guidance in the field of their expertise and help with finding information. The teaching atmosphere should be informal. Lecturers involved with the group of students should be available at agreed times to give advice as required and co-operate with other lecturers when a problem requires a joint solution or discussion. This may present timetabling problems but, with the PIA, students can be allocated self-study periods in which to perform their assignments.

CONCLUSION

When using Design as the core theme, the group of lecturers involved could be considered senior members of the Design office. There is a diversity of activity in such

integrative assignments, so students will require opportunities for research in libraries, workshops and laboratories. Therefore they are likely to be given more personal responsibility for completing the work satisfactorily.

Lecturers require staff development to supervise such assignments as doing this effectively requires a new approach to teaching and providing students with accessibility to a range of expertise in many fields.

Laura Landau, BSc (Hons) Industrial Information Technology, Birmingham Polytechnic (with Jonathan Davis of Knowledge Research, and Jeremy Mathers and Stephen Banbury, co-students)

Most of today's students have been exposed to 'information technology' for much of their time in education as computers are now an integral part of educational experience. Their experiences of computers in schools and colleges seem to have been beneficial to their intellectual development. In my case, I believe that using computers has considerably stimulated my self-confidence and self-motivation. However, like most people of similar age, I have been exposed to some educational software that I now realise was poorly designed, poorly presented, and poorly selected too. I may be wrong, but it seems that the quality of educational software was (and probably still is) judged mainly by a group of non-users - teachers. Of course, students are conditioned to like the activity of using computers; it may be that they see them as neutral and non-patronising. It is possible to mistake a class's enthusiasm for using computers as relating to enthusiasm for the particular piece of software. Commercial software designers spend a good deal of time on the human-machine interface and there has been much research into what makes a computer system easily used. Yet many computerised learning programs are designed without sufficient attention to the principles of good human-machine interface design.

I have recently read Professor Stonier's article in *FEU Technology Digest No.1*. No one could disagree that the economic future of this country depends on the continuing education of the working population. Professor Stonier states that 'the key to further education will be distance learning'. This seems to be incontrovertible. However, later in his article, he claims that 'although books, other learning media, tutors and peers will continue to play a vital part in the students' learning experience, most of the time will be spent using the computer'. And the university plans to 'network the students' bedrooms by the end of the academic year 1988/89'.

Well, I wouldn't have fancied the prospect of being cooped up in my room like a battery hen for most of the three years I spent on my course. I thought that the essence of education was the sharing of not just knowledge, but also life experience. I admit that this kind of distance learning might be the only way to update core training in new developments for practitioners in a specialised field. It might be endurable for short-span distance training but not, I think, for the marathon of a diploma or degree course. How will students trained in this way be able to cope with the real world, with real people with active and questioning minds?

Do my fellow students agree with my opinion? I devised a questionnaire and circulated it to a sample of 100. Their responses were based upon their past and expected future use of computers. Here are some of the findings:

86% saw computers as a useful tool in the learning process.

39% found it hard to sit in front of a terminal or longer than an hour and 60% for longer than two hours.

44% supported loans to buy their own microcomputer so they could work from home; 56% were not in favour.

The preferred methods of learning were:

- 11% for 100% lectures;
- 4% for 100% private study with own computer;
- 85% for a mixture, such as 50% lecture, 50% private study.

Quite clearly, it would be dangerous to draw any extreme conclusions from a small sample taken in a fairly informal way from a localised population of students. It seems reasonable to assume, though, that there would be some student resistance to such a radical change in learning methods. It would be interesting to hear the views of students at Bradford University when they have experienced the new system.

I was surprised that any student would prefer to take a course by means of private study alone. I suppose that Open University courses are mainly conducted in this way, but I understand that their summer schools are always well attended, not just for tutorial support but, probably more importantly, for contact with fellow students. I think the issue of how long students can comfortably use terminals needs to be studied further. I am informed that in many intensive computer applications in industry, users are required to

have brief rest periods at regular intervals. Despite the screens in most commercial installations being of good quality, the environment is carefully controlled, workstations ergonomically designed and displays sited to eliminate glare and consequent eye strain. It does not seem likely that these ideal conditions would be found in many students' systems.

A more serious concern, however, is with the quality of current educational software. Computer-assisted learning (CAL) has been around for a surprisingly long time but doesn't seem to be developing at as rapid a rate as other software applications. The Bradford University scheme may help discover which subject matter is most effectively communicated by traditional methods and which by computer assistance, and then perhaps some educational software that is neither tedious nor unintelligible will be developed.

But most importantly, I think that the first step should be to examine carefully our educational goals and consider the experiences that will enable our students to achieve them. In my view, education is a lot more than the acquisition of knowledge.

Dr Noel Meeko, Director of Marketing and Enterprise, Cheltenham and Gloucester College of Higher Education, The Park, Cheltenham

WHAT IS RISC?

RISC is a new buzz word for 'Reduced Instruction Set Computer'. Like many other aspects of computing, it is not really new in that the concept emerged from an IBM research project in 1975. It was followed by further work in the USA and, independently, in Britain in 1983. The American work was largely concerned with 16-bit machines, whereas in Britain research centred from the outset on a 32-bit data bus which allowed four bytes to be read simultaneously.

To understand RISC you should first consider the development of conventional microprocessors. The main hurdle was putting a complete microprocessor onto a single silicon chip. The development which followed was simply that of ever-increasing complexity. However, as chips increased in size, manufacturing yield declined, transition times increased and cost rose. Simultaneously, instruction sets became more complex because it was regarded as beneficial to improve the so-called power of the processor.

In modern and more complex processors, internal actions are controlled by a set of operating instructions called a micro-code. When a particular bit-pattern appears in an instruction, a sequence of micro-coded actions is carried out. The micro-code is stored in a read only memory (ROM) on the

microprocessor chip. As instruction sets increase in complexity, so this ROM occupies an increasingly larger proportion of the chip. However, when instruction sets are analysed, it is seen that the more complex operations are used infrequently and thus, for a large part of the time, chip area is being wasted.

A processor is only as fast as its longest instruction. If there is an instruction with many components, the instruction cycle must be long enough to allow them to respond. Thus, for simpler instructions, there is inbuilt and wasteful dead time every cycle. Elimination of the more complex instructions could speed up the overall process. The space saved on the chip can be more cost-effectively utilised to provide processing capacity. In addition, other techniques such as minimising 'pipelining', avoiding 'branching' and increasing the number of registers are possible. Additionally, two or more RISC chips can 'talk' to each other, allowing rapid transfer of instructions and data at the lowest possible level. This lends itself to the construction of fast and powerful multi-processor machines.

RISC strategies involve transferring the more complex or infrequently used instructions onto the compiler. The instructions which remain on the RISC processor are those which are:

frequently used by code generators,
normally embedded in compilers;
most advantageous to a language;
most efficient when implemented
in hardware.

EFFECT OF RISC ON COMPUTING

RISC allows the designer to reduce the silicon chip area needed, at the same time introducing a number of helpful features such as overlapping registers, cache memories and communications hardware. A computer with a reduced instruction set is not 'crippled'. It is more accurate to infer that RISC provides progress towards defining a methodology which can be used to advantage in implementing microprocessor architecture.

As the RISC concept was developed as long ago as 1975, it might be wondered why it has not entered the market-place sooner. Until quite recently, it has remained relatively dormant, being used in a few specialist areas such as graphics workstations, especially those using the Unix system. However, the past year has seen a number of manufacturers' products on the market with a RISC processor at their heart. Perhaps the name most familiar in education is Acorn with its Archimedes computer. The Acorn R140 workstation is Unix-based and utilises Acorn's 32-bit RISC processor. It has been designed for educational use and combines multi-tasking, multi-use, graphics, windowing and networking. It will also operate MS-DOS, giving access to the plethora of IBM PC compatible software.

Mips Computers are currently introducing their R2000 chip set, now being used as the processor in several different machines. Significantly, one of these is the Decstation from Digital Equipment. Motorola have developed the 88000 RISC chip set and we

may soon see a number of manufacturers using this processor. Sun Microsystems have licensed several semiconductor companies to produce their Sparc chip set and also have the advantage of close commercial ties with AT&T who created Unix.

This degree of RISC activity must indicate that this chip architecture has come of age and will be more widely used in future. Early RISC chips cost several thousand dollars each but because of increased yields are now affordable for normal computer production. They are becoming increasingly available from the major semiconductor companies, including INTEL with its brand new 80860 RISC chip designed to run MS-DOS or OS/2, and will have a significant effect on computer speed per unit cost.

IMPLICATIONS OF RISC FOR FHE

Knowledge, understanding, awareness and use of RISC chips, from software and hardware points of view, will be required in college courses - almost immediately in advanced further education and soon after in further education. A fact-finding study is required to analyse more fully the timetable for the introduction of RISC chips into industry and to determine the steps that should be taken to introduce the RISC concepts into the FHE curriculum. Ancillary considerations such as the effect of RISC on the curriculum include:

- the computers used in FHE classes (e.g. BBC Archimedes)
- CAD/CAM
- graphics
- CAL

FEATURES OF RISC

In defining RISC, debate may become heated. Without wishing to increase the temperature, it is probably true to say that most of the following features are normally found in a RISC processor.

Single-cycle operation for each instruction

Single-cycle instructions provide processing rates of millions of instructions per second (MIPS). To operate in single-cycle mode, an instruction must be inherently simple or supported by additional hardware logic.

Load/store design

Only load and store operations access memory external to the chip. All other instructions operate only on on-chip registers.

Hard-wired control

The avoidance of microcode speeds the operation because the microprocessor's hardware is not impeded by interpretation processes.

Relatively few instructions and addressing modes

By adherence to this philosophy, advantage is taken of reduced silicon chip area, easily decoded instructions, simpler addressing modes and faster execution.

Fixed instruction format

By simplifying the hard-wired decoding of instructions, the complexity of circuitry is reduced, which allows the system to run faster.

More compile-time effort

This affords the opportunity to off-load wasteful static run-time effort into a purpose-built compiler.

administration (e.g. financial delegation)
hardware purchases in future.

active rather than reactive.

This is one precious opportunity when we can, with reasonable certainty, anticipate the progress of computer technology. It would be regrettable not to grasp it and, with forward planning, render part of the curriculum pro-

A RISC seminar and exhibition for industrialists was held at Gloucester in March 1990, sponsored by the DTI's Technology Transfer Initiative. A Conference for FHE staff is planned for later in the year; details can be obtained from Noel Meeke.

In February 1989 I visited Copenhagen Teknikum, an engineering college. As with many European institutions, it is difficult to place the Teknikum on our educational spectrum, but I should judge that it overlaps further and higher education functions. There are six departments: Civil, Production, Mechanical, Electronic, Power and Export Engineering. My visit was mainly confined to the Mechanical Engineering Department, although I spent a day investigating the Production Engineering Department.

The Mechanical Engineering Department has 350 students, 28 teachers, five technicians and one secretary. There are two heads of department - one in charge of academic affairs and the other looking after resources. Both are elected by the staff, as are all the other supervisory staff, including the Principal.

The main course lasts three years and is based on six 20-week semesters. Classes run from 8.00 am to 1.35 pm, with a half-hour break; students work on projects in the afternoons. The college closes at 4.00 pm. There is also a one-year foundation course based in the Production Engineering Department. These students take Maths, Physics, Chemistry, English, German, Danish and Communication Studies.

I sat in on a fifth semester class in Design with 30 students. The subject was the design of welded structures; we would not cover this topic in anywhere near so much detail in the UK. The lecturer explained that because of the small internal market in Denmark, there is much fabrication and so welding is a very

important manufacturing technique. The class was held in Danish but I followed most of what was going on quite easily.

There was a good deal of constructive interaction between the teacher and the class. The method of teaching was interesting; members of the class were selected, in register order, to perform parts of a design analysis of a welded beam on the blackboard. The students I saw were highly competent and confident; on the few occasions where one was in difficulty others helped out. I had a chat with some of the students and found them confident, relaxed and friendly. The student-teacher relationship seemed excellent. I don't know whether the teacher (Hans Hansen) is typical, but he was an exceptionally good communicator and very well organised.

I spoke to many of the other lecturers and found them very open and informative, with a broad range of industrial experience. Many had worked outside Denmark. The average age of staff was probably higher than in a British department, may be due to the retirement age of 70.

All students possessed detailed sets of course notes, prepared by the staff and bought for a modest price from the college bookshop. They had also bought all the texts on the fairly large recommended book-list, in German, English and Danish. Each had a standard Hewlett-Packard programmable calculator.

I had a good look around the classrooms and laboratories. Although in an old building, the

classrooms are more spacious than ours tend to be. The laboratories and workshops are traditional, with few microcomputers apart from some used in project work. However, they have an excellent CAD facility - based on a VAX3200 driving seven high-standard workstations on which they run the integrated CAD system, EUCLID, and on which they are preparing to run the FEA system, PATRAN. They also have 12 Olivetti M24 microcomputers running AutoCAD, and another set of machines for general use. The library was small but, since it was specialised to engineering, I should guess it was fully adequate; it had a very good selection of journals, again in German, English and Danish.

I sat in with a group of teachers learning to use EUCLID. The training sessions are timetabled, and they were doing a set of graded exercises with the resident expert in attendance. I was told that they use the same training materials as the students and often work in parallel, exchanging notes and experiences, which seems an excellent idea.

I also attended a project tutorial. The students work in pairs and, judging from this project (designing a gearbox for a heavy machine for dyeing large rolls of textiles), are presented with quite major design problems. Although the work had not been going on for long, they were making good progress in a methodical way. The project was absolutely realistic; they were in contact with the firm through visits and, though I don't suppose they will finish up with a detailed design, I should guess the firm would be well satisfied with the result. Apparently, there is no

difficulty in getting projects of this kind from Danish firms which are regarded as being very helpful.

I had an interesting discussion with another group of students (in English, of course) about the advantages and disadvantages of their four-hour open-book examinations. Although I am generally in favour of these, I advanced the opposing view and they beat me hands-down in debate.

The mechanicals are housed in an old but comfortable building. They will shortly be moving to a new site which I visited because the Production Engineering department is already in residence. It was difficult to judge the quality of the production facility because most of the equipment had not yet been installed. The building, however, made me green with envy. It had excellent classrooms fitted with built-in audio-visual equipment, a language laboratory, a well-appointed lecture theatre, and was a most comfortable and efficient education machine. The CAD/CAM facility was just getting off the ground, but already had 12 industrial-quality workstations.

I have, over the last year, also visited educational institutions in France and Germany. Although it may be considered unfair to judge the quality of education from my limited experience, I should say that Danish students get one of the better deals. The college is under-equipped in some areas by British standards, but this is well compensated for by the close attention paid to curriculum delivery and materials, made possible by the limited number of full-time courses for

mature students. Where the UK appears to score is in our provision of part-time courses and continuing education. While it is difficult to make comparisons, due to the different systems, Denmark, like most other European countries, makes little or no attempt to attract external funding. They regard themselves as pedagogic agencies. I suspect that this may have to change.

Nic Evans, Producer of STARNET programmes, Polytechnic South West (formerly Plymouth Polytechnic)

STARNET is a two-year pilot project funded by the Training Agency and managed and delivered by Polytechnic South West. Programmes will be broadcast and made interactive by the integration of an audio-conferencing network into the production facilities.

AUDIOCONFERENCING

This is the linking of three or more geographically separate people by telephone. Plymouth Polytechnic conducted extensive experiments over a three-year period and over 200 conferences with groups of up to 100 participants.

Applications identified for further education include:

- distance and open learning;
- courses held at multiple sites;
- managerial meetings and conferences (to minimise travelling time);
- tutorials with students on industrial placement;
- contributions by experts.

Teleconferencing has been evaluated by M Harrison in 'Evaluation of Teleconferencing in Education and Training', MPhil thesis, Plymouth Polytechnic, 1986.

STARNET

STARNET TV programmes will be delivered live from the campus to Olympus satellite, which will transmit to most of Western Europe. The aim is to combine audioconferencing facilities with the satellite broadcasts, adding a new dimension to interactive distance learning. The pilot project will provide open learning texts and is aimed at three different audiences initially:

- the first series will consist of eight programmes relating to 'Starting a Business';
- the second will appeal to students in engineering and advanced engineering technology;
- the third provides updating programmes for professionals (including educationists), and will discuss important contemporary issues.

Interactive participation is the principal feature of STARNET; the greater this is, the greater will be the benefits expected in terms of assimilating and length and degree of retention.

The STARNET project will be independently assessed to identify learning and cost benefits within the UK.

EFFECT ON CURRICULUM DELIVERY

STARNET is expected to enable FE to

increase provision of distance learning while retaining student/tutor interaction at visual and audio level. As the cost of receiving equipment drops, more individuals should be able to participate. FE could become more able to meet the demands of individuals wishing to obtain appropriate knowledge and application elements to combine with practical skill training gained at their workplace. Finally, economies of scale could arise, possibly to the extent that, with multi-sound channels, open learning could be provided on a European scale.

Colleges wishing to participate in the pilot project should send for a free user pack from: STARNET, The Hoe Centre, Notte Street, Plymouth PL1 2AR.

Adapted from a summary report of the same title by William Hall, Director of TAFE, National Centre for Research and Development Ltd, 252 Kensington Road, Lea Brook, Adelaide, South Australia 5068

This report presents information about the results of an investigation into the extent to which Australian colleges sought to teach the social implications of technological change, and showed that these were largely ignored. Without a similar survey it is not possible to state the degree to which UK colleges take such factors into account. However, many of the ideas put forward are complementary to those that FEU has been promoting through work on aspects of the key technologies, which showed that these rarely occurred in UK courses at FHE levels unless specific steps were taken to include them. The lesson for UK course designers is that they must give careful consideration to the issues raised by Bill Hall. FEU would be interested in sponsoring work in this area; please contact Albert Clyde for further information.

INTRODUCTION

There are three sections in the main document. First, there is a discussion of the meaning of the social implications of technological change and the reason it is important to teach these. Second, examples of how it may be taught are given and, finally, a curriculum framework is suggested. At no point is it suggested that a course unit called 'Social Implications' should be offered as part of technological courses. The ideas should be incorporated into all courses by making

use of the numerous opportunities that already exist rather than by replacing existing material.

WHY TEACH SOCIAL IMPLICATIONS?

The social implications of technological change are the ways in which it can affect people, individually or as a group, and how such change is brought about by people.

FE courses must offer more than opportunities for basic skill training as the answers to 'Why?' and 'What if?' matter as much, if not more than, answers to 'How?'. The effect of these will be to produce course objectives which do not stop at knowledge, application and skills; attitudes also become important.

Too often the education system falls short when teaching science and technology. Social implications are treated superficially if at all, the chief emphasis being how people are affected (usually negatively) by changes in technology. This is particularly true in schools where some adopt a naive approach, for example: 'Pollution is bad; factories produce pollution; therefore they are not nice places to work in'. The fact that it is industrial production that leads to a high standard of living is completely ignored. It could be added that much popular press and television comment reinforces this viewpoint. Thus further education organisations must recognise that many students will be pre-conditioned about the social implications of social change on entry to college. Not dealing with social implications in a positive manner in further education courses could reinforce existing negative attitudes.

On the other hand, the view that schools should have the sole aim of preparing students for work, with a skills-based curriculum developing unquestioning, positive attitudes to industry is equally questionable.

REASONS FOR TEACHING THE SOCIAL IMPLICATIONS OF TECHNOLOGICAL CHANGE

Technology and technological change as part of our culture

Technology and technological change are important parts of our culture and should be understood by everyone.

At every level of society there is ignorance of technological change. At local and national levels there frequently appears not to be even an understanding of the important technology-culture link which includes industrial democracy, retraining, attitudes towards quality, and health and safety issues. The forging of the link should start at school, but rarely does this seem to happen.

Importance of being informed citizens

If further education courses are to be regarded as education rather than merely the acquisition of a narrow set of techniques or skills training, as well as a belief in technological change as a panacea to civilisation's ills, then not only should the techniques associated with technology be learned, but their *limitations, impact and use* within a particular approach to *problem solving* should be recognised as important issues.

Some of the most important current issues need a good general understanding of technological principles if sensible decisions are to be taken about major changes. One example is the energy crisis and changes in fuel technology: not understandable if a machine which ignores the second law of thermodynamics is used as a model; but readily understood with the more correct model shown in Figure 1.

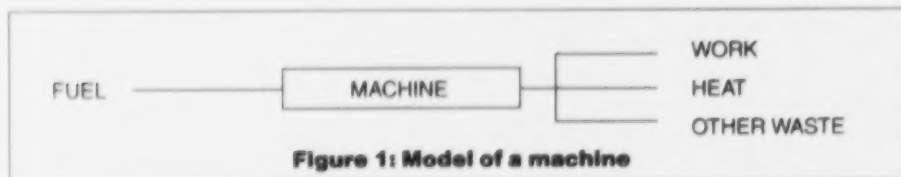


Figure 1: Model of a machine

How many of our students do not have even a basic grasp of the social implications of technological principles such as this and are unable to discuss (say) the legal implications of technological change?

Concern for the quality of life

There is widespread concern for the quality of life, especially the impact on it of changes in technology.

Albert Baez (the renowned American physicist and educationist) has claimed that to enrich the quality of life, education must inculcate the four Cs - curiosity, creativity, competence and compassion. Further education courses certainly emphasise competence. How many deal adequately with the others?

Social responsibility at work

Everyone needs to exercise social respons-

ibility in the workplace, especially when technologies change. Social responsibility at work embraces a large number of issues such as occupational health and safety, quality, industrial democracy and even privacy.

People need to be made aware of their social responsibilities; they will not usually arise spontaneously. Topics such as 'quality' are social responsibility issues because if a

'quality' culture is not quickly encouraged to permeate industry, the social future will be bleak.

'Values' component in technical education

There should be a 'values' component in technical education, especially when dealing with technological change. Technical education cannot be divorced from life; it must (by its very nature) be humanistic in its approach if it is to be relevant to students' and employers' needs.

The very purpose of technical education is to serve the needs of people; those graduating from further education courses will be living and working within society. This means that 'attitudinal' as well as 'knowledge' and 'skills' aims are important for these courses. One example will suffice - an attitude of service to the client, which should be common across

trades. Australia does not enjoy a good service reputation; frequently (and incorrectly) service is confused with servility. But the attitude displayed in the provision of service is of paramount importance.

Technology is practised within a social context

Changes in technology should be practised within a social context. The teaching of technological changes should not be isolated from people who are being affected in major ways.

There seems little need to give account of the present restructuring within industry and commerce because of the large amount of publicity given to it. The social context is changing rapidly. The main inter-relationships have been neatly summarised by Bill Ford in a variety of papers.

Technological change and employment

Much has been written in the past five years about the impact of technological change on employment. There are two, connected, main aspects to this - the changing nature of work (the types of jobs and how they are done; retraining and restructuring); and the emergence of key technologies. The United Kingdom Engineering Council has identified examples of these key technologies which have been classified into three groups:

- materials*: the building block products;
- components*: the sub-assemblies of systems;
- manufacturing and process*: the assembly techniques which combine elements from the other areas.

(For a detailed analysis see *The Key Technologies: Some Implications for Education and Training*, FEU/Engineering Council, 1988.)

With regard to employment prospects, how many students know that they will probably change jobs every few years and that retraining will be a fact of life? Do they know the reasons for this? An awareness of this will enable necessary changes to take place with much less trauma, and will help people prepare for change.

Impact of technology on education

The impact of technological change on education takes two main forms: it affects what is taught (content), and how it is taught (process). An example of 'what' was provided by *Computer Aided Design in FE*, FEU, 1988.

The process of delivering education has been discussed widely in many publications where the satellite, video disc, tele-conferencing, etc. have been described. These technologies offer new possibilities for the development and extension of open and distance learning.

THE IMPORTANCE OF 'WHY' AND 'WHAT IF?'

The social implications of technological change should be a thread running through further education courses. The absence of this leaves the questions 'Why?' and 'What if?' unanswered. Questions on 'How?', leading to the teaching of techniques, are insufficient due to the present rate of technological change. While further education

deals with 'How?' adequately, indications are that the other questions are largely ignored and the social implications of technological change are being neglected.

CASE STUDIES - TEACHING THE SOCIAL IMPLICATIONS OF TECHNOLOGICAL CHANGE

To seek case study material, the TAFE researcher circulated all 245 colleges in Australia, describing the project. Normally a very high response rate is obtained, but in this case only 11 colleges responded, and of these only six sent detailed material.

Two large colleges were visited to check the reliability of responses, including one which had not returned the questionnaire, but which the researchers thought was bound to have relevant information. In fact, a detailed survey showed that the college did not teach the social implications of technological change.

At the second college, all heads of school indicated that they realised the issue was important, but in fact most courses contained nothing. The few containing some information include facts about occupational health and safety (e.g. repetitive strain injury) or the applications of computers, but none went further. In one case it was implied that some external students were being exposed to technological change due to changes in the method of delivery of their education.

In all cases the 'Why?' was rarely considered and the 'What if?' completely ignored, although it was suggested that staff who had undertaken professional training recently

would be expected to teach in this way.

The material sent by colleges included the following:

one college in its computer science course had as one of its main aims the 'appreciation of some implications of computer use in contemporary society';

the same college had a computer studies course, one of its eight aims being 'to discuss the impact of computers in society' with topics of study which included 'the social implications of the computer';

a college of tourism and hospitality included, as one of its nine topics in a food science and hygiene course, the 'historical developments in food and nutrition with particular reference to Australia';

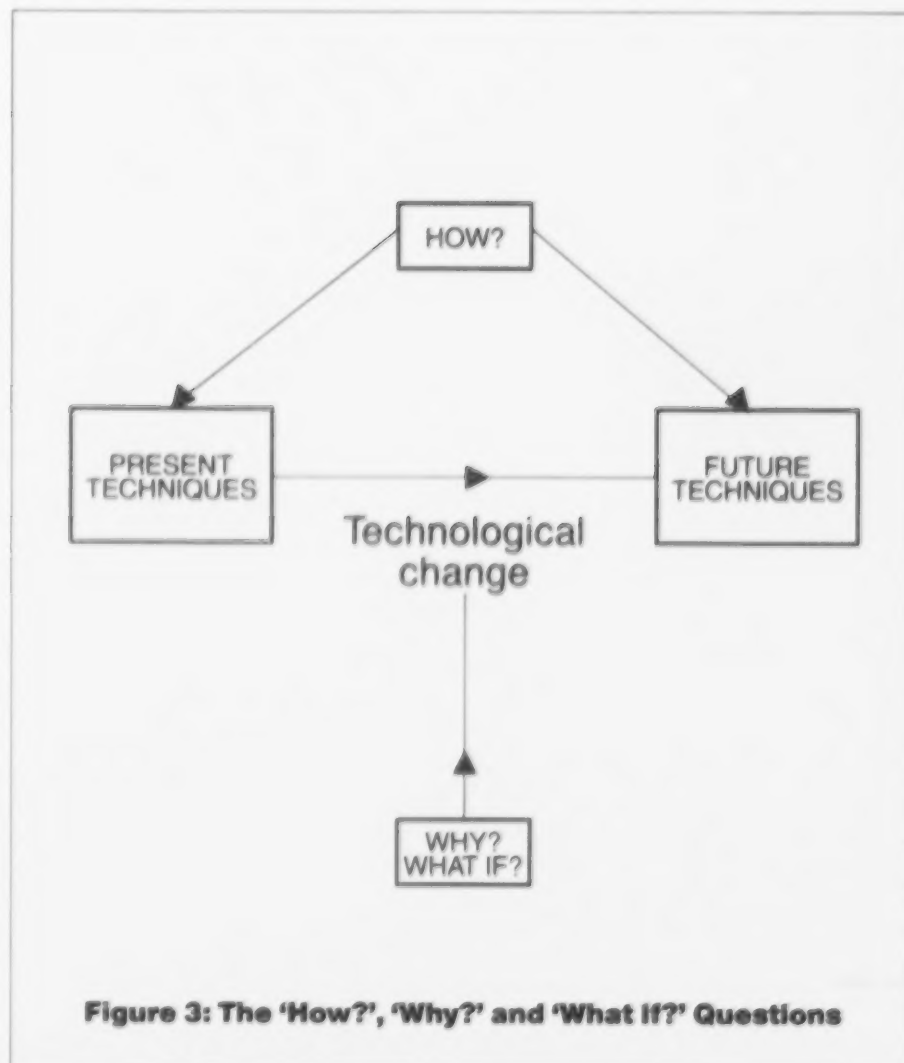
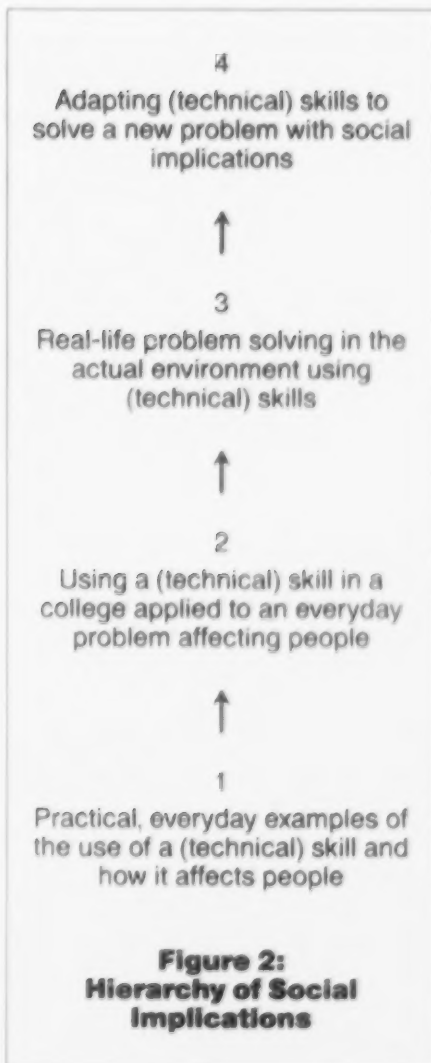
a food science course intends, as one of its aims, 'to give students an understanding of food in our society';

one college stated that 'all our course aims are affected by changes in technology, but we do not provide information to our students'.

One document which gave a thorough treatment of social implications was *Core Curriculum Revision for Fitting and Machining* (Ebsary, 1987). The publication includes sections on:

- the current industrial scene (with notes on change, dependency on technology, information systems);
- inadequacies in skills, motivation and organisation;
- recent developments;
- metals and manufacturing in the 1990s.

The report's educational recommendations included good social implication statements.



A CURRICULUM FRAMEWORK

The full report on the investigation describes a variety of structures which could be useful to curriculum planners when they are attempting to include the social implications of technological change in their courses and programmes. Such structures are important because they provide a framework and logic for making decisions concerning what should (or should not) be included. Suggestions that a topic seems a good idea, and/or might be useful or interesting are not logical criteria, and decisions made on this basis are unlikely to offer lasting relevance to a course.

There is probably a hierarchy of social implications, ranging from the presentation of everyday examples of the use of a technical skill and how it affects people, through to solving problems which have social implications. The hierarchy is shown in Figure 2.

It is fairly easy to find examples at level 1 (e.g. the optical fibre and its effects on communication; desktop publishing and its effects on the printing trade) but much more difficult to move up the hierarchy. The report discusses five models which should be of some help in this. One simple model is shown in Figure 3.

CONCLUSION

Teaching the social implications of technological change matters if students are to have an understanding of what is happening and why. Teaching the social implications should be a part of the education process. Unfortunately, the 'Why?' and 'What If?' questions seem to be generally neglected. This cannot be justified and is especially a matter of concern in these days of rapid technological change.

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No.2